Generative Joint Source-Channel Coding for Semantic Image Transmission

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Abstract

Recent works have shown that joint source-channel coding (JSCC) schemes using deep neural networks (DNNs), called DeepJSCC, provide promising results in wireless image transmission. However, these methods mostly focus on the distortion of the reconstructed signals with respect to the input image, rather than their perception by humans. However, focusing on traditional distortion metrics alone does not necessarily result in high perceptual quality, especially in extreme physical conditions, such as very low bandwidth compression ratio (BCR) and low signal-to-noise ratio (SNR) regimes. In this work, we propose two novel JSCC schemes that leverage the perceptual quality of deep generative models (DGMs) for wireless image transmission, namely InverseJSCC and GenerativeJSCC. While the former is an inverse problem approach to DeepJSCC, the latter is an end-to-end optimized JSCC scheme. In both, we optimize a weighted sum of mean squared error (MSE) and learned perceptual image patch similarity (LPIPS) losses, which capture more semantic similarities than other distortion metrics. InverseJSCC performs denoising on the distorted reconstructions of a DeepJSCC model by solving an inverse optimization problem using the pre-trained style-based generative adversarial network (StyleGAN). Our simulation results show that InverseJSCC significantly improves the state-of-the-art DeepJSCC in terms of perceptual quality in edge cases. In GenerativeJSCC, we carry out end-to-end training of an encoder and a StyleGAN-based decoder, and show that GenerativeJSCC significantly outperforms DeepJSCC both in terms of distortion and perceptual quality.